AMEDEO LOCATELLI - ANDREA VALCALDA

ENGINES OFF AT BERTH

Passenger ships, even when moored, have to keep their auxiliary engines running to generate the electric power needed to operate their onboard equipment. The Port Authority of Venice and ENEL *are working together on the realization of the first large-scale "cold-ironing" systems in the world, capable of supplying power to cruise ships from the shore, with the aim of turning Venice into a zero-emission port.*

The changing scenarios that are taking shape on the horizon with regard to the sustainability of the environment have given rise in recent years to a growing sensitivity on the part of the public to the possible pollution produced by ships moored in large tourist and mercantile ports.

The main objective that Western governments are setting themselves is to reduce the emission of pollutants and noise in ports, while maintaining at the same time the productivity and profitability of maritime traffic.

Thus ports are destined to become a point of excellence in terms of environmental sustainability by providing a supply of electric power to ships at their berths. This solution is known the world over by the terms "cold ironing" or "shore power."

To give an idea of the advantage that can be obtained from cold ironing in terms of the emission of pollutants, it has been estimated to result in a 30% reduction in the emission of CO_2 into the atmosphere and a 95% reduction in the emission of NO_x (nitrogen oxides) and particulates.

A result that can be obtained through a variety of technical modes

of supplying power to vessels moored in port, differentiated in relation to the type of craft—which require different amounts of power from one another—be they ships, ferries, yachts or pleasure boats.

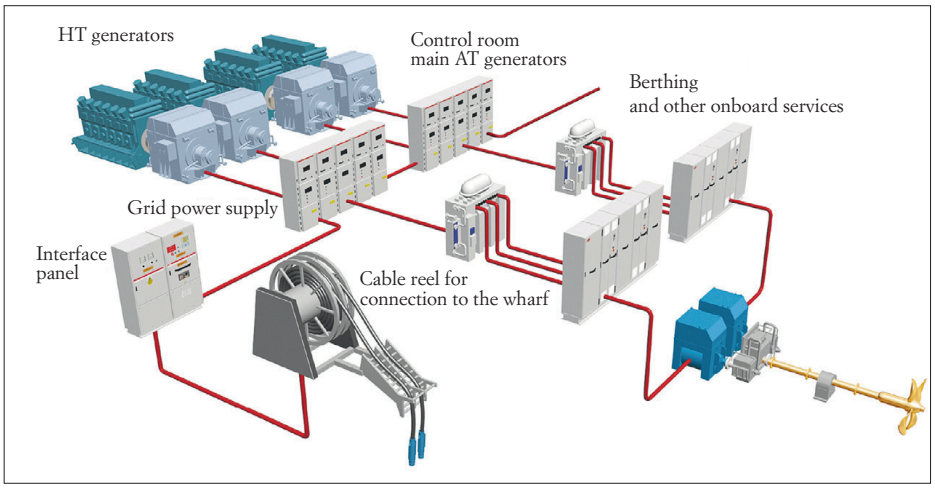
Two other important factors are the frequency and voltage at which the onboard electrical systems operate.

The frequency depends directly on the speed of rotation of the electricity generators on board and so is linked to technical and economic choices made by the shipowner. There are only two standard frequencies in the world: 50 and 60 Hz. The world's electricity grids on land differ in the frequency they use. America has adopted the frequency of 60 Hz while Europe has adopted that of 50 Hz.

Voltage, on the other hand, depends on the power that the generators on board have to supply for propulsion and to run electrical equipment. This too can be linked to technical and economic choices made by the shipowner.

For large and medium-sized cruise ships the voltage is either 11 or 6.6 kV, while for merchant ships and ferries it is generally 6.6 kV. For yachts and pleasure boats a voltage of 440 V is usually adopted.

Figure 1—Schematic diagram of a medium-voltage naval electrical system

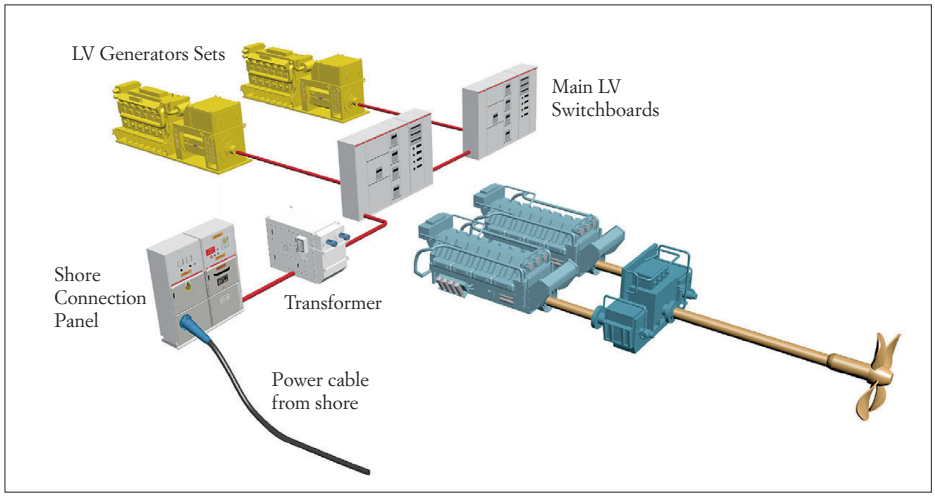


Source: *World ABB*, August 2010.

In the case of a medium-voltage naval electrical system the ship is fitted with a diesel/electric propulsion system and is equipped to re-

ceive power from shore through a connection panel located outside the control room of the ship and linked by a cable reel with plugs to be inserted in the sockets provided on the wharf.

Figure 2—Schematic diagram of a naval electrical system for the supply of low-voltage electrical power



Source: World ABB, August 2010.

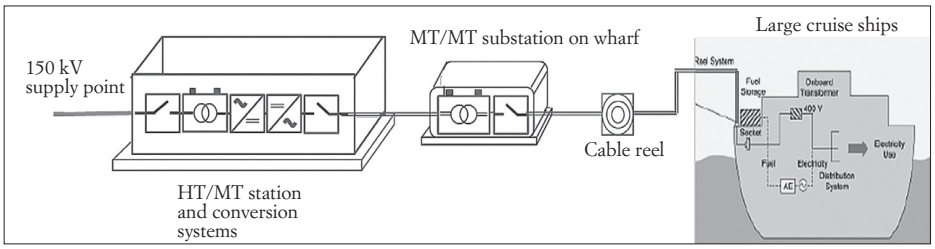
In the case of a naval electrical system for the supply of low-voltage electrical power the ship has diesel propulsion and an onboard electric system that operates at a low voltage. Power is supplied from shore through a connection panel located outside the control room of the ship with a socket able to receive the terminal plug of a cable running from the wharf. A transformer allows the voltage of the system on land to be adapted to the one on board.

The examples in figures 1 and 2 are indicative and limited to illustrating different types of naval electric systems, and provide only partial information on the real cold-ironing infrastructure of onshore electrical systems.

Figure 3 illustrates in schematic fashion the infrastructure of cold ironing and the onboard electrical system. The cold-ironing infrastructure is the one represented on the left of the figure and terminates at the onshore connection box located on the wharf. The station that connects to the public grid contains the high-voltage circuit breakers, transformers and the static inverters that allow the

grid frequency (50 Hz) to be converted to the frequency normally used in onboard electrical systems (60 Hz).

Figure 3—Cold-ironing infrastructure and the onboard electrical system



Source: ENEL—Illustrative scheme

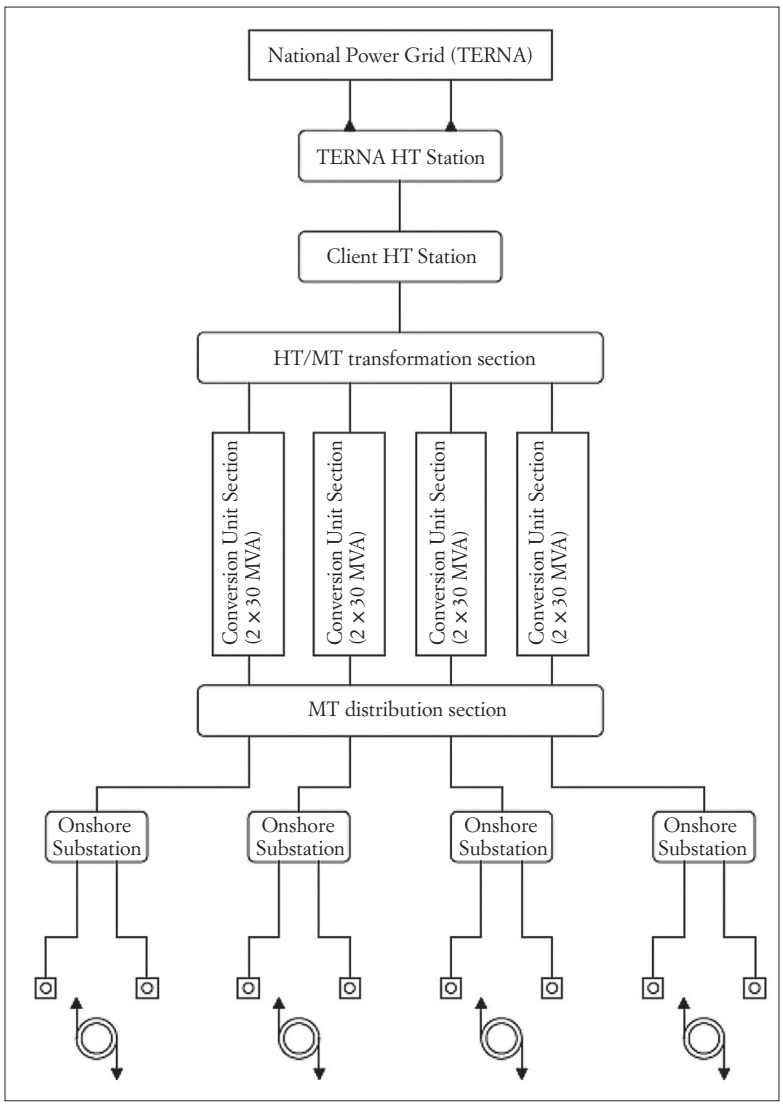
One of the most impressive projects for the electrification of a port that is being developed over this period and that could come into operation within the next five years is the one at the dock of Marittima in the Port of Venice. The infrastructure will be capable of supplying electric power simultaneously to four large cruise ships, which will therefore be able to turn off their auxiliary generators and power in complete safety all the services on board the ship (ventilation, air conditioning, kitchens, waste treatment and whatever else is essential).

According to the international technical standards in force with regard to cold ironing the maximum energy requirements of a large cruise ship are equivalent to 20 MVA (megavolt amperes).

Consequently the Marittima infrastructure will have an installed power of 80 MVA. A block diagram of the infrastructure is presented in figure 4.

The electricity will be taken from the underwater National High-Voltage Grid at 132 kV managed by the local transport system. Converting the current from high to medium voltage and then from 50 Hz to 60 Hz by eight 10 MVA inverters, the power will be supplied to four electricity substations located in a central position with respect to the ship's hull. From each substation shunts will run to two electrical boxes on the ground located at the stern and bow of the ship.

Figure 4—Block diagram of the project for electrification of the wharves at Marittima



Source: ENEL—Preliminary plan for the Port Authority of Venice.

A cable reel on a dolly will permit connection between shore and ship from the nearest box to the hatchway of the ship from which it is possible to gain access to the interconnection panel.

At this moment cold-ironing facilities in Europe suffer from a lack of reliable financial backing for realization of the works and of tariff

reductions for those who have to buy power from the shore. These handicaps will certainly be overcome by the international community and so the present conditions should not and cannot hold up these opportunities for the environmental upgrading and industrial revival of port areas.

The electrification of the Marittima dock and many other ports of the peninsula, tourist and mercantile, represents a great opportunity to improve the quality of the environment and as a consequence the quality of life of people who live close to the ports or spend much of the day there for work purposes.

A project that replicates on a large scale what is already functioning on a small one. In Venice in fact, given the importance that protection of the environment and environmental sustainability have for Venezia Terminal Passeggeri, the company has studied and constructed mini cold-ironing systems reserved for mega yachts and small cruise ships that take the concrete form of fixed points supplying high-power current installed on the Santa Marta wharf and at berth 15 of Marittima Passenger Port. A similar solution, which is awaiting authorization, is planned for Riva dei Sette Martiri where, from 2012, only yachts will be allowed to moor as permission for cruise ships to berth there has been revoked.

The objective of "zero emissions"—a reality for the berths closest to housing—will also be attained at the Passenger Port of Marittima, thereby giving concrete form to the plan for electrification of the wharves—submitted by ENEL to the Port Authority of Venice on October 28, 2011—from the environmental perspective that lies at the center of the strategies of development followed by Venezia Terminal Passeggeri, which on April 26, 2012, staged a world conference on cold ironing.

Santa Marta wharf:

At this wharf, located on the Giudecca Canal near the Marittima Passenger Port and within the urban area of the city, three power points have been installed, two with outlets supplying up to 250 amps (150 kW) and one up to 800 amps (around 400 kW).

This last outlet has powered a mega yacht for a long period, supplying a total of around 2 000 000 kWh. This connection permitted a saving of over 240 000 liters of fuel (and the related maintenance costs) and as a consequence avoided the emission of more than 200 metric tons of carbon dioxide and other gases in the nearby built-up area.

Tagliamento wharf:

This wharf is located inside the basin of Marittima where large passenger ships are also berthed. For this reason and to avoid possible obstructions during cruise activities, special mobile power points have been designed. These are positioned according to need and connected to special conveniently arranged outlets set inside wells flush with the ground.

These mobile power points have three outlets, two supplying a current of 250 amps (125 kW) and one supplying up to 400 amps (about 200 kW).

In addition, there are plans to install four more 250 amp power points on the occasion of the renovation of the central building of the wharf (109/110), which is due to commence shortly. These will make it possible to supply power along almost the entire length of the wharf.

Riva dei Sette Martiri wharf:

The wharf is located inside the urban area of the city of Venice, opposite the district of Castello. To keep to a minimum noise and emissions from the maxi yachts that stay at the wharf for several days, at the request of the local residents, VTP plans to install seven 250 amp power points. This project also envisages the construction of a specific transformer substation and a modification of the feeding system of the power lines on the part of the utility. In view of the particular artistic value of the area in which the Riva dei Sette Martiri wharf is located, the project has been developed paying due consideration to the architectural aspects of the structures installed. At present the work—whose completion is envisaged within the coming year—is on hold pending further approval from the competent municipal departments.